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ABSTRACTS OF TECHNICAL NOTES OF THE DIVISION OF OPERATIONS ANALYSIS.

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NATIONAL CENTER FOR EDUCATIONAL STATISTICS
Division of Operations Analysis

ABSTRACTS OF TECHNICAL NOTES OF

THE DIVISION OF OPERATIONS ANALYSIS

Edited by

David S. Stoller

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PREFACE

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TN-34 STUDENT-TEACHER POPULATION GROWTH MODEL: DYNAMOD II. Edward K. Zabrowski, John T. Hudman, Tetsuo Okada, and Judith R. Zinter, May 29, 1967.

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TN-36 METHODS OF PROJECTING BIRTHS. Tetsuo Okada, June 1, 1967.

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TN-38 SCHOOL SUBMODEL FOR LARGE URBAN SCHOOLS. Richard J. O'Brien, June 21, 1967.

TN-1 ANALYZING DIFFERENCES IN THE GROWTH OF TWO RATIOS. Edward K. Zabrowski, May 24, 1966.

It is shown that time differences in the rates of growth of the two ratios can be factored into (1) intercept differences, (2) numerator differentials, (3) denominator differentials, and (4) a covariance between (2) and (3). One of the ratios is selected as a standard and the other's performance is compared against it. Intercept differences are removed by creating a theoretical ratio equal to the product of the comparison ratio and the gross growth rate of the reference standard ratio. The difference between the theoretical ratio and the comparison ratio is then factored into numerator and denominator growth differences, and covariance. Next it is shown that if the deviations between the theoretical and comparison ratio parts (numerators or denominators) are small, the covariance will be small. For the example of personal income, the implication is that tendencies toward racial discrimination can be measured if the covariation is small (other factors, such as productivity, equal). Two potential uses are discussed.

TN-2 SELECTED BIBLIOGRAPHY: APPLICATION OF OPERATIONS RESEARCH AND ECONOMICS TO EDUCATIONAL SYSTEM STUDIES. Howard Vincent, July 15, 1966.

This selected bibliography contains references to 48 books and 50 journal articles dealing with the application of operations research and economic analysis to problems of educational planning. About 90 percent of the references cited are books published in the 1960's. Almost all of the journal articles cited were published in the 1960's.

TN-3 CONSTRUCTING A MINIMAL-LENGTH AREA-CONSERVING FREQUENCY POLYGON FROM GROUPED DATA. C. Marston Case, July 15, 1966.

The analysis of grouped observations and the problem of their graphic presentation is discussed. The definitions underlying the theory are developed and in order to compare the graphic presentations, histograms and frequency polygons four parts are considered: (1) The base line upon which the histogram or FP is constructed; (2) and (3) the two sides, which rise vertically from both

ends of the base line; (4) the upper outline (UO) which comprises the remainder of the histogram or frequency polygon. A method is given for (a) finding the minimal length area-conserving segments for a given frequency rectangle and (b) establishing the length of the upper line.

TN-4 EDUCATIONAL QUALITY: DEFINITION AND MEASUREMENT. Frederic D. Weinfeld, September 2, 1966.

The problem of defining what is meant by quality in education is addressed. It is suggested that the educational output of schools be used as the criteria for quality instead of the usual descriptive information about the schools and their practices. The change in student level of educational achievement is seen as a logical criterion measure of the quality of schools. Various efforts, past and present, in the measurement of school quality are discussed. It is suggested that school systems should be evaluated using the criterion of system efficiency as measured by output per unit input within classifications of schools according to their size, funds available, type of school, etc.

TN-5 PROGRAM BUDGETING FOR EDUCATION. Howard Vincent, September 15, 1966.

A list of general educational program categories is suggested, and several tables showing federal, state, and local financial support for some programs for the years 1959-60 and 1961-62 are displayed. It is demonstrated that these data do not provide sufficient program budgeting information nor are they related to program-oriented end products. Moreover, there is a lack of clarity as to the actual source of educational funds. In general, educational statistics have been gathered for a number of special purposes without regard to a comprehensive information system. Many statistics are assembled to meet ad hoc needs, with no particular regard for the overall problem of evaluation. The financial reporting system therefore reflects a collection of ad hoc needs rather than those specifically needed for program management. Definition of data needs is required for aggregation of local, state, federal, and private sources data for use in evaluating policy objectives, measuring alternative resource allocations, or assessing the returns to investment in specific program elements.

TN-6 THE ORGANIZATION FOR ECONOMIC COOPERATION AND DEVELOPMENT 1966 SYMPOSIUM ON THE APPLICATION OF OPERATIONS ANALYSIS TO EDUCATIONAL PROBLEMS. David S. Stoller, October 6, 1966.

This symposium contributed to an extensive program of the Organization for Economic Cooperation and Development (OECD) to stimulate scientific cooperation among member nations. The program procedure followed puts technical experts in touch with key managerial personnel who have administrative responsibility for employing new technology. In this instance, the symposium was regionally oriented to Scandinavia, and the managerial elements were mostly from the Norwegian educational system, which was well represented and included the Deputy Undersecretary of State for Education, key directors in the Norwegian Ministry of Education, and a large number of regional superintendents of education. The Operations Research (OR) experts were drawn from Western Europe and the United States. Presentations were given on OR studies of educational problems and OR techniques which could be applied to education problems. Discussions of technical problems by educational managers with the OR experts were held to explore possible solutions utilizing OR techniques.

TN-7 A TECHNIQUE FOR PROJECTION OF OCCUPATIONAL EDUCATIONAL REQUIREMENTS FOR STATE EDUCATIONAL PLANNING AREAS. William C. Morsch, November 18, 1966.

The objective of the proposed technique is to provide projections of vocational education needs based on projections of employment by major industries. The technique calls for projections at major Standard Metropolitan Statistical Area (SMSA) and rest-of-state levels. Employment projections for 11 industries by state and selected SMSA's are the basis of the model. Employment projections for industries are allocated among occupations according to coefficients produced from the 1960 Census. By means of a conversion matrix, the occupations are transformed into educational requirements using 7 major vocational education fields. Results of the calculation indicate the number of people who will be employed in jobs for which training in a specific vocational field would have equipped them. The technique is designed to allow comparison with projections of other agencies. Details of the two computer programs used are described in an appendix.

TN-8 AN EXAMINATION OF DATA ON IOWA CHILDREN TO DETERMINE PATTERNS OF PERFORMANCE. Abt Associates, Inc., November 17, 1966.

As part of their work in preparing an education cost-effectiveness model, the investigators studied longitudinal data on Iowa school children. The researchers were looking for patterns of early academic performance which would serve as evidence of later failures. In general, patterns for low performance disadvantaged children were mixed. Several different types of patterns were identified: (1) Spread of effects, where early limited failure tends to generalize to several areas; (2) Convergence of effects, where many early failures narrow to one or two key areas; (3) Parallel effects, where students do poorly in one or a number of areas, but the patterns remain the same; (4) Diamond pattern, where early failure will be limited, will expand to a number of areas, and will finally diminish.

TN-9 AN AGE-SPECIFIC SCHOOL ATTENDANCE PROFILE FOR DROP-OUT ANALYSIS. Stanford Research Institute, November 17, 1966.

From their examinations of Census data, the investigators suggest the following hypotheses in drop-out rates: (1) Drop-out is more strongly associated with parental education than with family income; (2) drop-out rates are higher for rural than for urban children; (3) for a given level of permanent family income and parental education, there is no significant difference between drop-out rates of white and non-white children; (4) there is a positive correlation between the tendency to be below modal grade for the age group at age N, and being a drop-out at age N + 1; (5) there is a high negative correlation between family income level and the pupil being below modal grade for his age group; and (6) being below modal grade is a function of parental education.

TN-10 ON DEPARTURES FROM INDEPENDENCE IN CROSS-CLASSIFICATIONS. C. Marston Case, November 18, 1966.

This note is concerned with the concepts involved in cross-classification of observations. Primary concern is directed toward two-dimensional cross-classifications. A conceptual framework for the characterization and

and comparison of cross-classification is established. Some of the existing methods for characterization of cross-classifications are discussed and a new approach is proposed for characterizing and making inferences from cross-classifications. An indication is given for treating Markov processes as cross-classifications. There are numerous examples which clarify the presentation of the material. This note unifies material from diverse sources.

EA 001 062

TN-11 BIRTH AND DEATH PROJECTIONS USED IN STUDENT-TEACHER POPULATION GROWTH MODELS. Tetsuo Okada, November 14, 1966.

This note presents a brief description of the methodology used to project births and deaths in DYNAMOD II (See TN-34). For death rates, the most recently available data (1964) by sex and race was used and assumed to be constant over the period of projection. For projected number of births, Grabill's marriage-parity-progression method was employed. This method takes account of the variables of marriage, parity (number of previous children born), and birth interval (time between marriage and successive children).

EA 001 063

TN-12 ESTIMATION OF AGE TRANSITION PROBABILITIES. Judith R. Zinter, December 8, 1966.

This note describes the procedure followed in estimating age transitions for DYNAMOD II, a computerized Markov chain model characterizing the flow of students and teachers through the educational system over time (See TN-34).. The age transitions are presented in the form of probability matrices, one for each sex-race group. By means of these matrices, one can find the probability that an individual will (1) remain in a given age group, (2) move into the next age group, or (3) die. The age groups for which transition probabilities are estimated are 0-4, 5-14, 20-24 25-44 years old, and 44 years old and over.

TN-13 SOME QUANTITATIVE ASPECTS OF THE INSTRUCTIONAL PROCESS. William J. Gavin and Murray Spitzer, December 9, 1966.

Recent emphasis on equal educational opportunity has called for an increased need for knowledge of the basic mechanisms of the educational process. Particularly pertinent today is knowledge of the influence of environment on achievement. In one study cited in this note, the researcher developed a correlation between drop-out rate and median monthly rental of the community. However, perhaps the most promising source of information on the factors influencing achievement is the 1966 survey report by the Office of Education, Equality of Educational Opportunity.

TN-14 AN OVERVIEW OF THE ELEMENTARY AND SECONDARY COST-EFFECTIVENESS MODEL AND SUBMODELS. Abt Associates, Inc., December 9, 1966.

This paper summarizes highlights of the design concept of an elementary and secondary cost-effectiveness model. The paper briefly discusses five submodels and their interrelationships and functions: (1) school; (2) instructional process; (3) community interactions; (4) costs and (5) cost-effectiveness. The School submodel is the production process of the system. The Instructional Process submodel computes the specific improvements in student achievement and attitude. The Community Interactions submodel estimates the impact on seven community variables of the changes in education system output. The Cost submodel accounts for all direct and indirect costs required to implement incremental educational programs. The Effectiveness submodel is the program in which the analysis and the output of the results determined by the other submodels are computed and summarized.

TN-15 THE SCHOOL SUBMODEL. Abt Associates, Inc., December 9, 1966.

The School submodel is one of several submodels which comprise the design for an "Elementary and Secondary Cost-Effectiveness Model," (See TN-14). The School submodel has three major subroutines: the school flow matrix,

course of study selection, and drop-out routine. The school flow matrix consists of nodes at each grade/achievement point. Using probabilities of success or failure at each point, this subroutine calculates the numbers of students progressing from kindergarten through high school graduation. The course of study selection subroutine allocates students of a district among the available courses of study. Ultimately the graduation from a particular course will be linked to earnings potential. The change in drop-outs as a result of incremental educational program changes is calculated by the drop-out subroutine.

TN-16 THE INSTRUCTIONAL PROCESS SUBMODEL. Abt Associates, Inc., December 9, 1966.

The Instructional Process Submodel is one of several submodels which comprise the design for an "Elementary and Secondary Education Cost-Effectiveness Model," (See TN-14). Basic to operation of the model is the determination of the effects on attainment of alternative educational proposals. Computations to determine these effects are carried out in this submodel. Underlying the Instructional Process Submodel is the hypothesis that the culturally-disadvantaged child fails in school because he is not sensitized to the scholastic environment.

TN-17 THE COMMUNITY SUBMODEL. Abt Associates, Inc., December 9, 1966.

The Community Submodel is one of several submodels which comprise the design for an "Elementary and Secondary Education Cost-Effectiveness Model," (See TN-14). This submodel is a set of subroutines which convert data base information, instructional process, attitudinal data, and school submodel achievement data into indicators of community factors. Typical is the earnings potential subroutine. This is a procedure for quantitatively assessing the impact of a proposed educational program upon the ability of the target population to earn a living. Another subroutine correlates achievement scores with social origins. If the correlation is low, equality of educational opportunity is presumed to be high.

TN-18 THE COST SUBMODEL. Abt Associates, Inc., December 9, 1966.

The Cost Submodel is one of several submodels which comprise the design for an "Elementary and Secondary Education Cost-Effectiveness Model," (See TN-14). This model computes the total cost of an incremental educational program, including direct and indirect expenditures. To accomplish the latter, the model will compare resources currently available in the school with their utilization rate to arrive at an evaluation of resources available to fill supporting requirements. In addition, editing and diagnostic error routines are built into the Cost Submodel.

TN-19 THE EFFECTIVENESS SUBMODEL. Abt Associates, Inc., December 9, 1966.

The Effectiveness Submodel is one of several submodels which comprise the design for an "Elementary and Secondary Education Cost-Effectiveness Model," (See TN-14). The function of the Effectiveness Submodel is to receive the outputs of four operating submodels of the system, plus information from the updated data base, and provide output for the user. Outputs will show the changed values for the variables of interest, as a result of the implementation of the proposed programs.

TN-20 THE COMPUTATION. Abt Associates, Inc., December 9, 1966.

The Computation Submodel covers operation of the cost-effectiveness model for educational proposals (See TN-14). It can be used to evaluate alternative proposals for particular communities. The three areas of interest in the calculation are: (1) data base preparation, (2) model operation, and (3) cost-effectiveness analysis and presentation of results.

TN-21 FACTOR ANALYSES OF ACHIEVEMENT MEASURES FROM THE EDUCATIONAL OPPORTUNITIES SURVEY. George W. Mayeske and Frederic D. Weinfeld, January 18, 1967.

Factor analyses were conducted on the five ninth-grade achievement measures from the Educational Opportunities Survey (EOS). The five measures are:

(1) Non-Verbal Ability; (2) Verbal Ability; (3) Reading Comprehension; (4) Mathematics Achievement and; (5) General Information. Analyses were performed for ten different racial, ethnic and regional groups as well as for the total ninth grade sample. The first principal component for the total ninth grade sample accounted for approximately seventy-five percent of the variance among the intercorrelations. The relative ordering of the achievement measures on this first factor from highest to lowest were: Verbal; General Information; Reading Comprehension; Math Achievement; and Non-Verbal. This same trend for the magnitude of the first factor and the relative ordering of the achievement measures was found for the other ten groupings. It was concluded that a single achievement composite rather than five separate ones could be used in future analyses and that this could be obtained by utilizing the weights from the first principal component of the total ninth grade. Means, standard deviations, intercorrelations, and factor weights are exhibited for each group.

TN-22 EDUCATIONAL ACHIEVEMENT AMONG MEXICAN-AMERICANS: A SPECIAL REPORT FROM THE EDUCATIONAL OPPORTUNITIES SURVEY. George W. Mayeske, January 9, 1967.

This report summarizes findings from the Educational Opportunities Survey (EOS) that are of particular relevance to Mexican-Americans. Some of these findings show that: approximately twenty percent of the differences in achievement among Mexican-American students could be attributed to the differences in the kinds of schools they attend and that this dependence is about one and one-half to two times as great as for the white majority; at the 16-17 year-age level 20 percent more of white than Mexican-Americans are enrolled in school; use of a language other than English in the home may detract from achievement but the possession of verbally enriching materials in the home (such as newspaper, magazines, and an encyclopedia) and kindergarten attendance may facilitate achievement; the economic and educational circumstances of the parents as well as their involvement in the child's education were found to substantially influence achievement; the influence of parental involvement increased over the years; the achievement test scores of Mexican-American students increased as the proportion of white students in the school increased and this trend was more pronounced in the later grades; teacher attributes such as years of experience and education have an appreciable relationship with student achievement; and

Mexican-American students who believe that "hard work" is more important for success than is "good luck" score approximately eight points higher in achievement than those who believe "good luck" is more important.

TN-23 In Preparation.

TN-24 URBAN EDUCATION SYSTEMS ANALYSIS. Stephen C. Clark, Richard J. O'Brien, and C. Marston Case, January 20, 1967.

This note describes a conceptual model to be used in aiding educational planners evaluate policy relative to the location and concentration of educational facilities within urbanized areas. The note is intended to indicate the scope and the nature of the factors to be included in the analysis of these decisions. Certain submodels are described: the urban submodel; the school submodel; and the cost submodel. The urban submodel is described by areal units which are defined by their location and the socio-economic characteristics of their inhabitants. The school submodel is described by functional classifications of school plant floor areas and personnel staffing ratios required to service the student population. The cost submodel is described by several elements that are used in the determination of total facility cost. Among these elements are the construction of new school plants, special equipment, staff, land acquisition, current operating and transportation costs. The operational indices that are the outputs of the above three submodels are used as the quantitative basis for the selection among alternate policies. The operational indices include the racial and socio-economic composition of the school attendance area, the initial capital and operating cost estimates of the school system, transportation data and utilization rates of the school facilities.

TN-25 REPORT ON THE ORGANIZATION FOR ECONOMIC COOPERATION AND DEVELOPMENT 1967 CONFERENCE ON SYSTEMS ANALYSIS TECHNIQUES IN EDUCATIONAL PLANNING. David S. Stoller, February 10, 1967.

The purpose of this meeting of the Organization for Economic Cooperation and Development (OECD) was to bring together educational planners, professional staff, and technical experts from the various OECD countries, and from the

staff of OECD, for international interchange of planning needs, technical methods, and for progress reports on technical studies. Previous OECD meetings in this series have been oriented to stimulating a dialogue among educational planners, systems analysts, and econometricians to explore the feasible interface between planning needs and technical capabilities. This meeting was particularly interesting in that a great proportion of the discussions and presentations were based on studies sponsored by educational agencies and institutions, whereas earlier meetings in the series relied heavily on the contributions by individual scholarly efforts. Typical examples of the presentations based on current educational applications: (1) "Applying Systems Analysis Techniques to Educational Administration and Planning," Department of Education and Science, United Kingdom; (2) "Admission to Schools, Colleges, and Faculties by Centralized Electronic Data Processing Systems," Swedish Planning Institute, Sweden; (3) "The Measurement of Equal Educational Opportunities," Office of Education, United States of America; (4) "Simulation and Rational Resource Allocation in Universities," Institute of Educational Research and the University of Toronto, Canada. The above partial listing does not include a number of the other presentations of outstanding character, depth, and relevance but serves to indicate the current involvement of educational agencies with systems analytical studies of vital problem areas.

TN-26 A STUDY OF LONGITUDINAL PATTERNS OF FAILURE AMONG HIGH SCHOOL DROP-OUTS AND POORLY PERFORMING GRADUATES. Abt Associates, Inc., February 16, 1967.

This study was undertaken as part of the development of a planning model for evaluating elementary and secondary education (See TN-14). The study sought to determine quantitatively the relationship of variables in two areas: (1) do certain patterns exist with respect to poor performance in elementary and secondary school? (2) are there patterns of performance which distinguish the potential drop-out from his poorly-performing classmates who manage to complete school? As a consequence of this pilot study, the investigators feel that many poorly-performing high school students could have been identified early in their careers. Areas of critical performance were primarily in English courses and in mathematics. While many students showed a spreading pattern of failures, no significant pattern differences distinguished the drop-out from the graduate student. Boy drop-outs tended to leave steadily through high school, but girls left most frequently in the 12th grade.

TN-27 COST-BENEFIT ANALYSIS OF EDUCATION. Alexander M. Mood and Richard Powers, March 30, 1967.

Cost-benefit analysis encounters severe difficulties when one attempts to apply it to education. A complete understanding of this problem is likely to be a number of years away. However, education is an important and expensive element in our society; any contribution that can be made to its effectiveness or efficiency will pay handsome returns. A comprehensive quantitative model of the American educational system will require resources applied over time. Such an analysis is mandatory; we cannot allocate over $50 billion per year to an activity without making substantial efforts to allocate it effectively. The implementation of an operational accounting system which will identify program costs will require widespread revision of the accounting systems of 25,000 school districts. As we acquire knowledge and methods, our understanding of the interactions that occur in the educational process, their relative sizes, their relationships, and what can be done to modify them will grow.

EA 001 016

TN-28 DROP-OUT AND RETENTION RATE METHODOLOGY USED TO ESTIMATE FIRST-STAGE ELEMENTS FOR DYNAMOD II. Edward K. Zabrowski and John T. Hudman, April 20, 1967.

DYNAMOD II is a computerized Markov-type demographic model of the time flows of the educational population (See TN-34). The model was built in two stages: in the first stage, the population was divided into male and female, and the transition probabilities for the respective educational groups were estimated. In the second stage, these probabilities were factored further to develop sex-race-age-educational category parameters. This note concentrates primarily on the procedures used in estimating the male/female flow parameters (transition probabilities) for elementary, secondary, and college students. Estimating formulas and data sources are given. An appendix is devoted to secondary school students' drop-out rates. The estimating procedures used for the remaining transition probabilities is discussed in TN-24 and TN-39.

TN-29 Cancelled.

TN-30 COST MODEL FOR LARGE URBAN SCHOOLS. Richard J. C'Brien, April 26, 1967.

This note presents the mathematical equations required to estimate the cost resulting from the construction and operation of a large school facility. The equations are presented in parametric form, with only limited data presented for the estimation of parameters. The cost model is part of a larger model (Technical Note 24) that can be used to evaluate educational policy relative to the location and concentration of educational facilities within urbanized areas. The costing procedure is developed to the extent that new facilities and staffing cost are estimated independently of the existing system. Some of the cost elements which are discussed and for which mathematical formulas are given, are the following: construction of new school plants, personnel staffing, transportation requirements in terms of number of buses and daily operation, acquisition of special equipment and land and financing of capital. The mathematical formulas are presented as a function of student enrollment size where appropriate. The relationship between school enrollment size and cost is discussed in a general manner. An example of the cost estimating procedure is given for a large school enrollment (10,400) facility.

TN-31 In Preparation.

TN-32 ITEM RESPONSE ANALYSES OF THE EDUCATIONAL OPPORTUNITIES SURVEY TEACHER QUESTIONNAIRE. George W. Mayeske, Frederic D. Weinfeld, and Albert E. Beaton, Jr., May 18, 1967.

This report presents the results of an analysis of the item response alternatives selected by elementary and secondary teachers in responding to 66 of the questions from the Educational Opportunities Survey Teacher Questionnaire. The sample is composed of 36,241 elementary and 24,008 secondary teachers. The sample numbers for each item response alternative are adjusted by their sampling weights to estimate teacher population values. Estimated population values as well as estimated population percentages are given for each response alternative. In addition, the mean and standard deviation of scores on a contextual vocabulary test are given for the teachers selecting each item response alternative. These latter values are converted to standard scores with a mean of fifty and a standard deviation of ten for each question. A discussion is included of some selected results.

TN-33 In Preparation.

TN-34 STUDENT-TEACHER POPULATION GROWTH MODEL: DYNAMOD II.
Edward K. Zabrowski, John T. Hudman, Tetsuo Okada, and Judith R. Zinter, May 29, 1967.

DYNAMOD II is a computerized Markov-type flow model which projects 108 separate population groups over selected intervals of time. These population groups are cross-classified as to sex, race (2 categories), age (6 categories), and educational status (3 levels of students and teachers, respectively) and an "Other" category. DYNAMOD II uses "transition probabilities" to move the population groups through time. These probabilities are estimates of the changes that a person in one classification in a given year will change classifications (or die) by the following year. The birth data used in the model are supplied in the form of projections in absolute numbers which are added in to the youngest age group at the appropriate time. After each year is projected, the population groups are subtotaled and printed out as desired. DYNAMOD II can provide estimates of the impact on the educational population of proposed policy changes or of sudden shifts in the structure of the educational system. For example, if policymakers wish to know what effect will be produced by a policy designed to decrease the elementary school teacher turnover by one percent, DYNAMOD II can supply not only information on the new levels of teacher projections, but also can provide estimates of the rate at which these adjustments will take place. Not only are these estimates possible for the various tiers of student and teacher structures in the model, but changes outside the educational system, such as in birth and death rates can be handled as well. It follows that the impact of policy changes on system characteristics, such as the student-teacher ratio, can also be estimated.

TN-35 AN ALGORITHM TO DETERMINE RELATIVE IMPORTANCE OF PROJECTS.
William K. Winters, May 31, 1967.

There are many characteristics which are relevant to determining the urgency of individual tasks composing the total workload of an organization: due date, priority number, etc. These characteristics must be made commensurable in order to provide a linear ordering of the tasks. This

note presents the mathematical description of the problem and furnishes two algorithms for constructing solutions. Two examples are discussed and several examples illustrate the mechanics of the algorithms for each. An appendix furnishes an ALGOL code for one of the solutions.

TN-36 METHODS OF PROJECTING BIRTHS. Tetsuo Okada, June 1, 1967.

This note presents the various methods currently in use for projecting births. In particular, the basic method of cohort-fertility (Bureau of the Census), and three alternative methods: (1) age-specific, (2) cohort-fertility (Scripps), and (3) marriage-parity-progression, are described. Finally, an overview is given of recent trends in birth projection modeling efforts and new approaches to the problem of predicting fertility.

TN-37 In Preparation.

TN-38 SCHOOL SUBMODEL FOR LARGE URBAN SCHOOLS. Richard J. O'Brien, June 21, 1967.

The school submodel is a component of a model that can be used to evaluate educational policy relevant to the location and concentration of educational facilities within urbanized areas (see Technical Notes 24 and 30). The school submodel is concerned with the definition of the basic input data representing educational policy on facilities, staff and programs. The specification of these inputs, their interrelationships and the presentation of the data in the form necessary for the later evaluation (full model) of costs and effectiveness is the objective of this note. School facilities are defined in terms of the functional areas (measured in floor space) within the school plant required to provide a given program of service to the student population. Regular instructional, supplemental instructional and service and structure areas are considered. The regular instructional area requirements are determined through the application of straightforward space

per pupil factors. Supplemental requirements are considered from a probabilistic and deterministic approach. The deterministic approach defines space requirements in terms of frequency of scheduling availability of the use of the facility, and engineered space requirements. The probabilistic approach defines space requirements (and also staff requirements) in terms of the historical data of course selection and confidence levels of space and staff utilization based on the Poisson probability distribution. Service and structure areas are estimated through statistical factors. Staffing requirements are estimated through the application of standard statistical staffing ratios to different personnel categories. Some discussion is given on the relationship of scope of curriculum and utilization of specialists and enrollment size.